N91-14925

HIGH-SPECTRAL RESOLUTION OBSERVATIONS OF THE 3.29 μm EMISSION FEATURE: COMPARISON TO QCC AND PAHS.

A.T. Tokunaga,* K. Sellgren,* A. Sakata,** S. Wada,**, T. Onaka,***
Y. Nakada,***, and T. Nagata****
*Inst. for Astronomy, Univ. of Hawaii, 2680 Woodlawn Dr., Honolulu, HI 96822
**Univ. of Electro-communications, Chofu-shi, Tokyo 182, Japan
***Dept. of Astronomy, Univ. of Tokyo, Bunkyo-ku, Tokyo 113, Japan
****Univ. of Kyoto, Sakyo-ku, Kyoto 606, Japan

Two of the most promising explanations for the origin of the interstellar emission features observed at 3.29, 3.4, 6.2, 7.7, 8.6, and 11.3 μm are: quenched carbonaceous composite (QCC) and polycyclic aromatic hydrocarbons (PAHs). Details can be found in Sakata et al. (1987) for QCC and in Leger and d'Hendecourt (1987) for PAH.

~~In~~ Fig. 1 we show high-resolution spectra of the 3.29 μm emission feature which were taken with the Cooled-Grating Array Spectrometer at the NASA IRTF at Mauna Kea and previously published by Nagata et al. (1988) and Tokunaga et al. (1988). These spectra show that the peak wavelength of the 3.29 μm feature is located at 3.295 ± 0.005 μm and that it is coincident with the peak absorbance of QCC. The peak wavelength of the 3.29 μm feature appears to be the same in all of the sources we have observed thus far. However, the width of the feature in HD 44179 and Elias 1 is only 0.023 μm, which is smaller than the 0.043 μm width in NGC 7027, IRAS 21282+5050, the Orion nebula, and BD+30°3639.

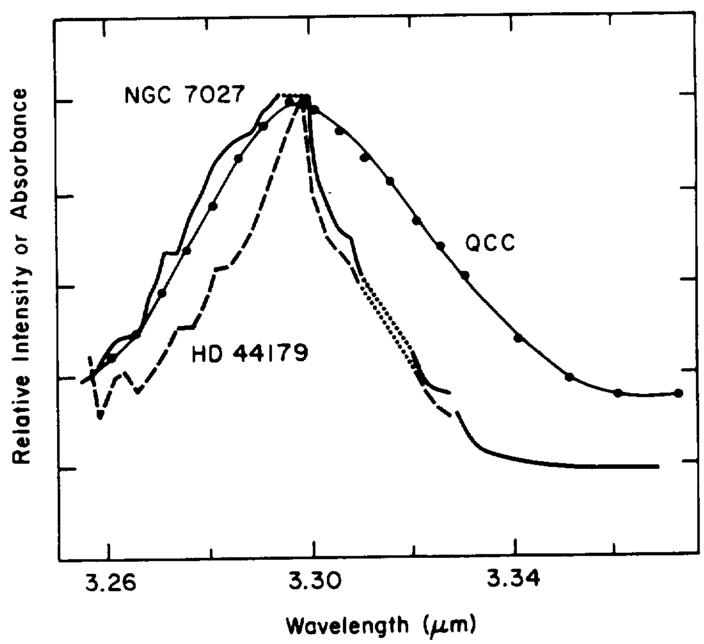

Fig. 1. Spectra of NGC 7027 and HD 44179 at a resolving power of 1400 compared to the absorbance of QCC.

Spectra of NGC 7027, QCC, and PAHs is shown in Fig. 2. The spectrum of QCC shown was taken after the QCC was heated to 500 °C in a vacuum, and at this temperature, the QCC bands at 3.4-3.6 μm are much weaker compared to the room temperature sample. The spectra of PAHs shown were taken at room temperature.

In Fig. 2 we show only the PAHs which have a peak near 3.295 μm; many others were measured but did not provide such a good match to the interstellar emission feature. Indeed, we measured over 30 PAHs and only benzene and benz(a)pyrene showed a peak exactly at 3.295 μm. Note that the width of the interstellar emission feature is less than or equal to 0.043 μm (40 cm^{-1}), so that combining the spectra of many PAH molecules would give rise to a feature at 3.29 μm which is much broader than what is observed. Also, the aromatic C-H bond of PAHs produces multiple features near 3.28-3.29 μm which is not observed in the interstellar medium.

In summary, QCC matches the 3.29 μm interstellar emission feature very closely in the wavelength of the peak, and it produces a single feature. On the other hand, PAHs rarely match the peak of the interstellar emission feature, and characteristically produce multiple features. We therefore suggest that QCC produces a much better match to the 3.29 μm interstellar emission feature.

We show in Fig. 3 and 4 additional spectra obtained in the same manner as the spectra published by Nagata et al. (1988) and Tokunaga et al. (1988). NGC 7027, Orion (position 4), and BD+30°3639 all have a profile for the 3.29 μm that is the same within observational errors. Also, Nagata et al. (1988) show that this emission feature is the same for NGC 7027 and IRAS 21282+5050 as well. On the other hand, spectra of HD 44179 and Elias 1 (see Fig. 4) show that these objects have a profile which is similar in shape but quite different that of the other objects shown in Fig. 3. A detailed comparison of the NGC 7027 and HD 44179 profiles is given by Tokunaga et al. (1988). In summary, high-spectral resolution observations of the 3.29 μm feature shows at least two types of emission profiles for this feature. The reason for this difference is not known at this time.

Leger, A., and D'Hendedourt, L.B.: 1987, in Polycyclic Aromatic Hydrocarbons and Astrophysics, ed. A. Leger, L. d'Hendecourt, and N. Boccara (Dordrecht: Reidel), p.223.

Nagata, T., Tokunaga, A.T., Sellgren, K., Smith, R.G., Onaka, T., Nakada, Y., and Sakata, A.: 1988, Ap. J. **326**, 157.

Sakata, A., Wada, S., Onaka, T., and Tokunaga, A.T.: 1987, Ap. J. Lett. **320**, L63.

Tokunaga, A.T., Nagata, T., Sellgren, K., Smith, R.G., Onaka, T., Nakada, Y., Sakata, A., and Wada, S.: 1988, Ap. J., **328**, 709.

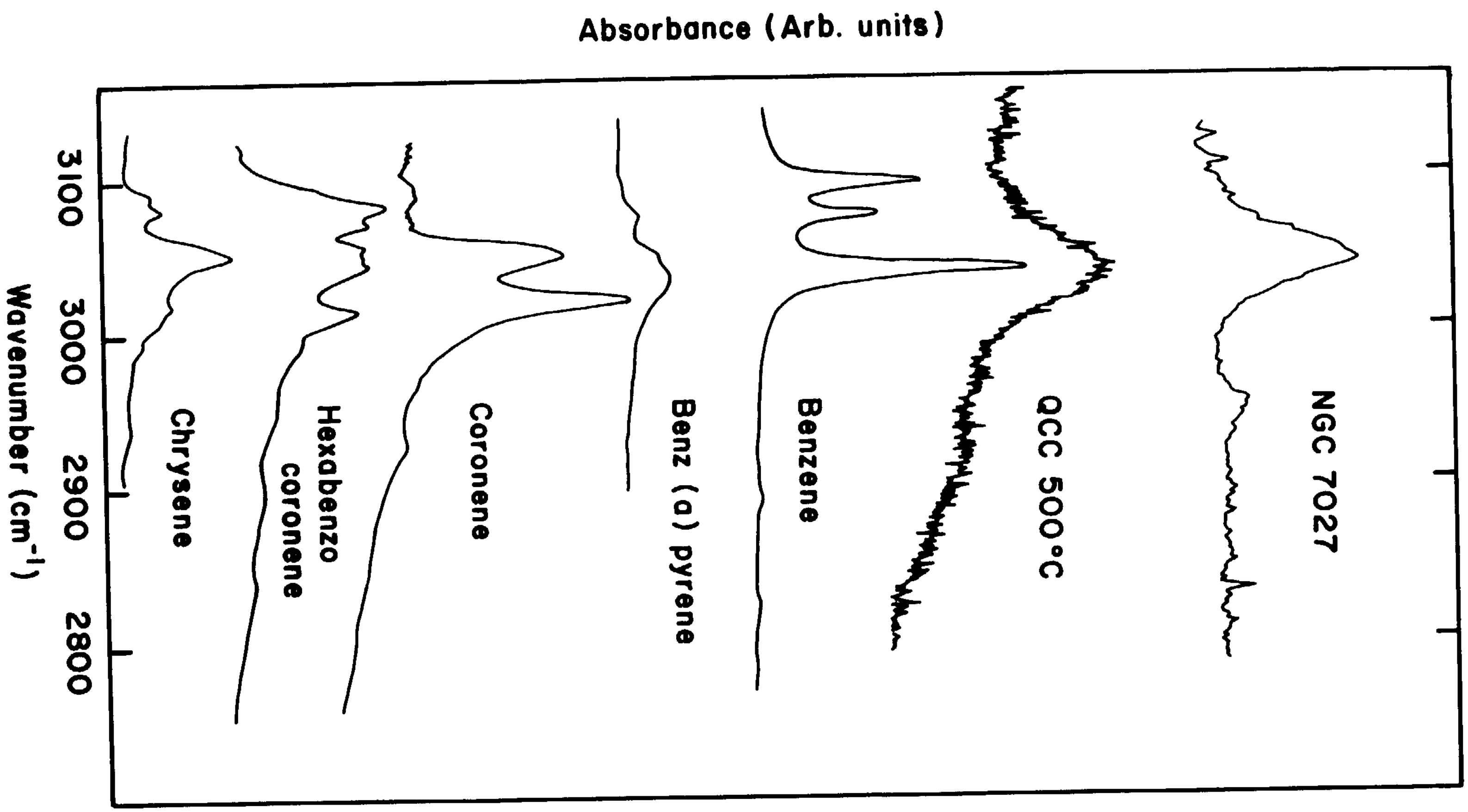

Fig. 2. The absorbance of QCC and PAHs taken at a resolution of 1 cm^{-1} compared to the emission spectrum of NGC 7027. The very strong Pf-δ line at 3.297 μm has been removed from the spectrum of NGC 7027.

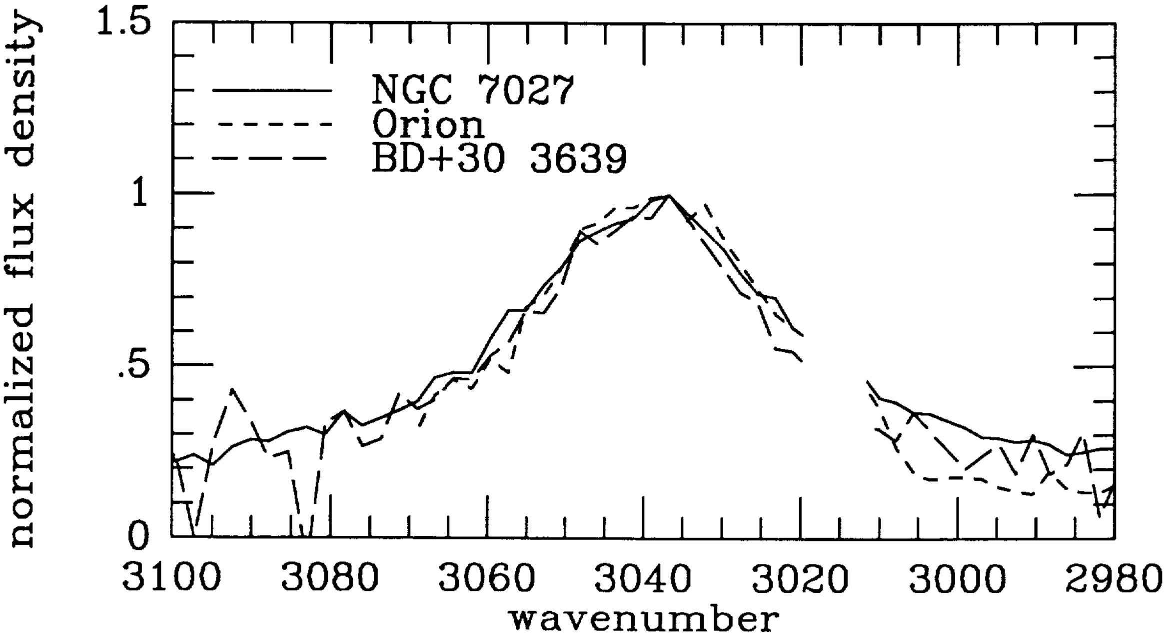

Fig. 3. Spectra of NGC 7027, Orion (at position 4), and BD+30°3639 taken at a resolving power of 1400. The strong Pf-δ line has been removed from the spectrum of NGC 7027 and BD+30°3639. The strong telluric methane band precludes data from being taken between 3010 and 3020 cm^{-1}. The point-to-point scatter is indicative of the noise level.

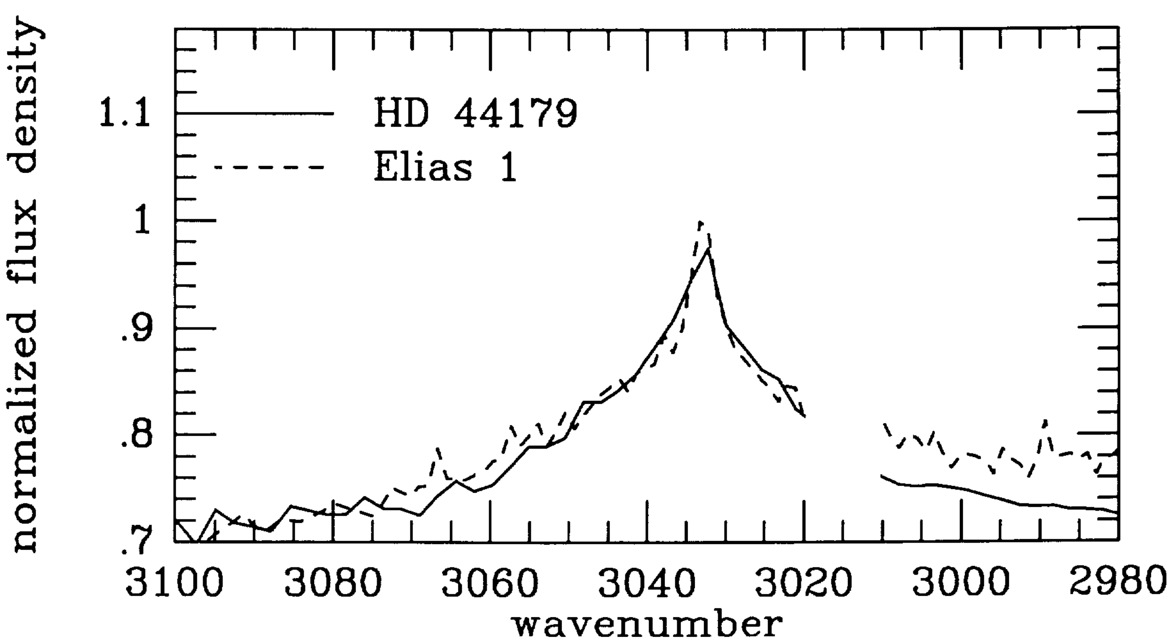

Fig. 4. Spectra of HD 44179 and Elias 1 at a resolving power of 1400.